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Final Report of the Impacts of the National Math + Science Initiative's (NMSI's) College Readiness Program on High School Students' Outcomes

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Abstract

The National Math + Science Initiative's (NMSI's) College Readiness Program (CRP) is an established program whose goal is to promote science, technology, engineering, and mathematics education in high schools to improve students' readiness for college. It provides teacher, student, and school supports to promote high school students' success in mathematics, science, and English Advanced Placement (AP) courses, with a focus on students who are traditionally underrepresented in the targeted AP courses.

Through a federal Investing in Innovation Fund (i3) validation grant awarded to NMSI in 2011, CRP was implemented in a total of 58 high schools in two states—Colorado and Indiana—beginning in the 2012–13 school year. American Institutes for Research (AIR) conducted an independent evaluation of the impacts of CRP on students' AP outcomes in these schools for the three cohorts of schools that adopted the program in sequential years, using a comparative interrupted time series (CITS) design that matched comparison schools to program schools in the two states. Overall, schools implementing CRP demonstrated significantly larger increases in the share of students taking and passing AP tests in targeted areas relative to comparison schools in each of the three cohorts of schools, and the gains in CRP schools were sustained over time.

Fidelity of program implementation was evaluated using a fidelity matrix approach required as part of the National Evaluation of the i3 program, which showed that not all elements of the program were implemented with high fidelity. Teachers and students were not always able to attend all meetings, and schools did not always meet negotiated enrollment targets. Teacher survey data indicated that teachers found the professional development activities provided by CRP to be the most helpful support they received under CRP, and students reported that the tutoring and special study sessions were the most helpful. Although the program provided financial incentives to both teachers and students that were tied to student performance on AP tests, these incentives were considered the least important element of the program by both teachers and students.

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Executive Summary

The National Math + Science Initiative's (NMSI's) College Readiness Program (CRP)—formerly known as the Advanced Placement Training and Incentive Program—has operated in more than 1,000 high schools across 34 states and the District of Columbia since its inception in 2008. The program's goal is to promote science, technology, engineering, and mathematics education by providing teacher, student, and school supports over a 3-year period to increase students' success in mathematics, science, and English Advanced Placement (AP) courses in high schools. The program focuses on students who are traditionally underrepresented in the targeted AP courses.

In 2011, NMSI received a 5-year Investing in Innovation Fund (i3) validation grant awarded by the United States Department of Education to implement CRP in Colorado and Indiana. Schools were actively recruited to participate in the program under the grant, with the same requirements for participation that schools would normally have to meet. The first cohort of 18 schools (divided between Colorado and Indiana) began participation in the 2012–13 school year, followed by 21 schools in the 2013–14 school year and 19 schools in the 2014–15 school year.

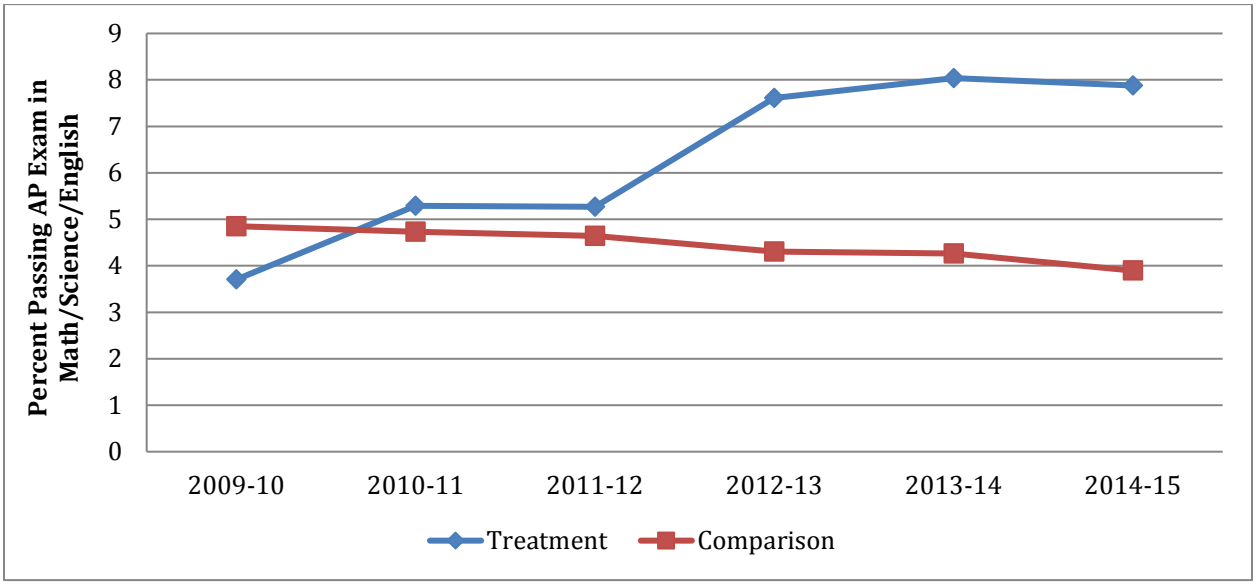
As part of NMSI's i3 grant, American Institutes for Research (AIR) conducted an independent evaluation of both the impact and the fidelity of implementation of CRP and provided data on findings to the National Evaluation of the i3 (NEi3) program using required reporting templates. This report provides a summary and discussion of results on both impact and implementation fidelity and also presents findings from surveys of teachers and students that AIR conducted that were not required as part of NEi3 reporting.

AIR evaluated the impact of CRP using a comparative interrupted time series (CITS) design. The key outcome variables for the school-level intervention were the share of all students (Grades 10–12) in a school taking AP tests in targeted subjects and the share of all students (Grades 10–12) who passed these tests at a level that would typically be considered equivalent to college-level coursework. Schools that participated in the program (i.e., treatment schools) in each cohort were statistically matched to a set of comparison schools that were of similar size and demographics within the same state and had comparable AP performance prior to CRP implementation. The impact of CRP on a given student outcome was estimated as the difference between treatment schools and comparison schools in the change in the outcome over time, before and after the start of CRP implementation.

The primary confirmatory outcome of the program was the share of Grades 10–12 students in a school who passed at least one AP test in the targeted subjects of mathematics, science, or English. The program provided supports to schools over a 3-year period, and data were available for all 3 implementation years for only the first cohort. The figure below shows the impact of the program over time for Cohort 1 schools by year of implementation (beginning in school year 2012–13), where the impact is shown as the difference between the lines plotted for treatment schools and comparison schools. The graph shows that although there was little change in the outcome variable for comparison schools over time, the share of all Grades 10–12 students in CRP schools who took and passed AP tests increased beginning in the first year of the program, and differences were sustained into the second and third years.

The differences between program and comparison schools were statistically significant for all 3 years. Findings were similar for measures of AP performance in different subjects and combinations of subjects (mathematics alone, science alone, either math or science, or English alone) for this cohort. Additionally, there were similar results for the 1-year and 2-year effects within the second cohort and significant (but smaller) first-year effects for the third cohort (which tended to include smaller schools).

Percentage of Students Passing AP Exam in Math/Science/English From 2009–10 to 2014–15 in Colorado and Indiana, by Study Group



Notes. Number of schools = 36 (18 treatment, 18 comparison).

The treatment group means for all years and the comparison group means for baseline years were unadjusted means. The means for the follow-up years for the comparison group were adjusted means based on the estimated difference between the treatment and comparison groups in the deviation from baseline to each follow-up year.

The evaluation also included analyses of fidelity of program implementation at the school level. Fidelity of implementation was evaluated using a matrix approach required as part of the National Evaluation of the i3 program, and the overall finding was that not all elements of the program were consistently implemented with high fidelity. Most notably, teachers and students were not always able to attend all meetings, and schools did not always meet negotiated enrollment targets. The approach used to measure fidelity of implementation was relatively stringent, in that for most indicators at least 80% of schools were required to meet a target for implementation. The targets for schools were either dichotomous (e.g., enrollment targets were either met or not) or required that a specified share of individuals participate in a required activity (e.g., that 80% of teachers attend summer institutes).

Survey results for teachers showed that teachers found the professional development activities provided by CRP to be the most helpful support they received, and students reported that tutoring and special study sessions were most helpful. Although the program provides financial incentives to both teachers and students that are tied to test performance, these supports were considered to be the least important element of the program.

Introduction

Preparing students for postsecondary success in science, technology, engineering, and mathematics (STEM) fields is a national priority. In the United States, job opportunities in STEM fields are growing. The Bureau of Labor Statistics has projected that about one million STEM-related jobs will be added to the economy and that overall employment in STEM professions will grow by about 13% by 2022 (Vilorio, 2014). High school students, however, are often unprepared for postsecondary STEM disciplines, potentially preventing students from taking advantage of these job opportunities.

Data for high school students who took the 2016 ACT College Entrance Exam (covering 58% of graduating high school seniors) revealed that 41% of the students were considered prepared for college-level mathematics and only 36% were prepared for college-level science (ACT, 2016). These data showed substantial differences in college readiness by race and ethnicity. Across racial groups, 70% of Asian American students and 50% of White students met ACT's college readiness benchmarks for mathematics, whereas only 27% of Hispanic students and 13% of African American students met these benchmarks. Similarly, 56% of Asian American students and 46% of White students met ACT's college readiness benchmarks for science, but only 21% of Hispanic students and 11% of African American students met these benchmarks.

One approach to better preparing high school students to attend college and pursue STEM-related fields is to provide them with coursework that is equivalent to that taught in college. The National Math + Science Initiative (NMSI) developed the College Readiness Program (CRP) (formerly known as the Advanced Placement Training and Incentive Program—APTIP) to support rigorous Advanced Placement (AP) coursework that better prepares students for postsecondary education, and postsecondary STEM disciplines in particular.

CRP provides supports to high schools over a 3-year period, with the goal of increasing the number of students who take AP courses in STEM-related areas (including English) and the expectation that larger numbers of students will take and attain test scores that many postsecondary institutions accept as indicative that the student has taken coursework comparable to their offerings (i.e., typically 3 or higher on a 5-point scale). Program supports include training of teachers, provision of supplies and equipment to schools, tutoring of students, and provision of incentive payments to teachers and students that are tied to AP performance. The program is expected to change the culture and the operation of schools in such a way that gains realized over the 3 years of support provided by CRP can be sustained.

As part of the federal Investing in Innovation (i3) Fund established under Section 14007 of the American Recovery and Reinvestment Act of 2009, NMSI was awarded an i3 validation grant in 2011 to implement CRP in approximately 60 high schools in both Colorado and Indiana over 3 school years (2012–13, 2013–14, and 2014–15). As part of NMSI's grant application, American Institutes for Research (AIR) proposed and subsequently conducted an independent evaluation of the program to assess its impact and also the fidelity of implementation by NMSI in the two states. This report presents findings from the evaluation about the impact of CRP, as well as findings about the fidelity of implementation based on the "fidelity matrix" approach required as part of the National Evaluation of the i3 program (NEi3).

Program Background

NMSI is a national nonprofit organization launched in 2007 that seeks to increase students' engagement and success in STEM education through several programs, including CRP, which focuses on supporting high schools, their teachers, and their students. CRP has since been implemented by NMSI in over 1,000 high schools in 34 states. NMSI also has implemented the program in schools serving military bases; however, these schools are not included in the current evaluation. Schools enter CRP through an application process in which they agree to open AP classes to all students, meet performance goals that are set in collaboration with NMSI, and implement activities specified by NMSI.

NMSI supports the implementation and replication of CRP at schools through a structure that provides oversight at the national level for overall program and fiscal management. Under the NMSI program management structure, the organization forms partnerships with other nonprofit organizations in participating states. NMSI refers to these partnerships as NMSI state agents (NSAs). Each NSA (one per state) provides oversight for the day-to-day implementation of CRP across the state and acts as NMSI's agent supporting districts, schools, and teachers in the state.

In each participating state, the NSA provides substantive content support for teachers in program schools through three content specialists—one for each of the three core subject areas (science, mathematics, and English). The content specialists work closely with teachers, through planning and providing professional development, resources, monitoring, consultation, and problem solving. Content specialists, in collaboration with the NSA, select lead teachers at the schools participating in CRP to arrange and lead internal content area meetings for the AP teachers.

CRP uses the College Board's AP program within schools because AP is an established high school program widely used across the nation with a rigorous curriculum designed to prepare students for college-level coursework (https://www.collegeboard.org/about). Research shows that AP's college-level coursework standards are related to postsecondary success (College Board, 2014; NMSI, 2014). Students who master AP coursework and pass AP exams are 3 times more likely to earn a college degree (Morgan & Klaric, 2007). AP also is associated with success in specific postsecondary disciplines. Students who take AP mathematics and science courses are more likely to earn postsecondary degrees in STEM fields (Tai, Liu, Almarode, & Fan, 2010).

CRP also uses the AP program because AP exam scores are standardized and widely accepted as evidence of college preparedness within a tested subject. At the end of each AP course, students take an AP exam that assesses their mastery of the course content. Students earn a score of 1 through 5 on the AP exams; scores of 3 or above are typically considered passing scores. CRP uses these scores to measure college readiness consistently across schools implementing the program. Therefore, all CRP schools are expected to offer AP courses, expand their enrollment in these courses, and expand AP course offerings as necessary. NMSI provides additional support to schools by supplying needed equipment and supplies, including specialized items for their coursework such as special calculators and laboratory equipment.

The next section provides an overview of CRP and its key components, which were the focus of the analysis of fidelity of program implementation in this evaluation.

Program Description

CRP expects to meet the goal of increasing student achievement and college readiness in STEM disciplines by implementing four key components within schools over 3 school years: (1) program management, (2) teacher supports, (3) student supports, and (4) awards, as detailed in this section. At the end of the 3 years, schools are expected to maintain the program with their own resources, although NMSI continues to make program materials available to them. The performance of schools outside of the 3-year window of support was not examined as part of this evaluation.

Program management includes making changes to school culture and putting processes in place to implement CRP in schools. NMSI is responsible for overseeing national resources and implementing fiscal and program management systems, including the monitoring of the key milestones that define CRP.

To this end, NMSI, in conjunction with the NSAs, trains content specialists who then work with schools on-site for one full week in the summer prior to the first year of program implementation. During this training, the content specialists learn how to manage and monitor each aspect of the program, such as supporting and mentoring AP teachers, and managing unique situations, such as different learning styles across teachers and different school cultures. Content specialists meet during a 2-day retreat each year to receive further training, discuss lessons learned, and collaborate on solutions to concerns.

Each CRP school also has a designated administrator who is either a school administrator or someone who works closely with the AP program at the school to implement CRP and serve as a school liaison for the NSA. Lead teachers manage the implementation of internal content meetings. Under this component, each NSA submits data to NMSI three times a year on AP course offerings, AP course enrollment and demographics, and AP exam results, and also provides an annual performance report.

Teacher supports are a critical component of CRP. Teachers are supported through training, access to content specialists, and cross-grade-level teams (referred to as “vertical teams”) to help align instruction across grades. The purpose of these supports is to increase teachers’ content knowledge and improve instruction, especially instruction in AP courses. All AP teachers are provided content-based training sessions and workshops on AP standards, and lead teachers who provide overall supervision of AP programs within schools additionally participate in summer training sessions on monitoring and mentoring for CRP. Lead teachers manage vertical teams to connect AP teachers and pre-AP teachers who teach the same subject in a professional learning community.

During the course of the program, AP teachers in CRP schools are expected to attend the appropriate College Board Summer Institute each year that they participate in the program. These institutes provide a 4-day intensive, content-focused training led by certified College Board trainers. The teachers are also provided with online curricular resources that can be used in their instruction.

Lead teachers and content specialists in mathematics, science, and English who have extensive experience in AP courses constantly monitor the AP teachers within schools participating in CRP so that they can assist the teachers with instruction (e.g., model lessons) and ensure that each teacher is providing the sequencing and rigor needed to achieve significant student growth, as shown by improved AP exam scores. This includes ad hoc one-on-one trainings for individual teachers.

To provide additional professional development to teachers, NMSI also provides three 6-hour Saturday study sessions during the year, which are taught by master AP teachers. Teachers learn both content and pedagogy in these sessions.

Student supports under CRP include tutoring and Saturday study sessions specific to AP courses. Each participating AP teacher is expected to provide students with a minimum of 40 hours of afterschool tutoring every year. Students are offered at least four Saturday study sessions in AP mathematics, science, and/or English disciplines, which are led by subject-matter experts; these sessions include the opportunity to take mock versions of AP examinations. Students also have access to online resources related to their homework.

The College Readiness Program also supports both teachers and students by providing financial incentives to teachers and students who participate in the program that are tied to student performance on AP exams in targeted subjects. At the end of the school year, teachers are given cash payments of $100 for each of their students who passes an AP exam, plus a $1,000 bonus if a targeted number of students earn passing scores. Students receive a $100 cash reward for each AP test that they pass among the targeted subjects. The awards are meant to motivate students, teachers, and administrators to implement CRP with fidelity and create a school culture that promotes success in rigorous courses. Additionally, the program covers at least 50% of exam fees to reduce barriers to student participation in the AP program.

Previous Impact Evaluations of CRP

There have been several evaluations of CRP across multiple states covering its implementation by NMSI since 2008, along with evaluations by Jackson (2010, 2014) of an earlier version of the program in Texas. Jackson studied the program implemented in nearly 1,500 schools in Texas over 10 years (1994–2005). Using a difference-in-differences approach, he analyzed the outcomes of student cohorts in schools before and after program implementation in comparison with outcomes for the same student cohorts in schools that were not implementing the program. Jackson found that after implementation of the program, enrollment in AP courses in program schools doubled and the total number of students in school who passed AP exams within program schools increased by about 45%. Student performance on the SAT/ACT was also significantly higher in program schools than in comparison schools (Jackson, 2010). In addition, Jackson (2014) examined longer term outcomes of the program in urban schools and found that students who participated in this program were about 8% more likely than comparable students to attend college. Students who went on to attend college were also more likely to have higher GPAs and to persist in college.

In an unpublished study of the CRP program in six states that adopted the program beginning in 2008, Holtzman (2010) found that the program had a significant and positive effect after 1 year

on the share of students in schools who took STEM-related AP courses in program schools relative to matched comparison schools within the same states. Using a comparative interrupted time series (CITS) design, Holtzman found that CRP was associated with a doubling in the share of students within a school taking AP tests in targeted subjects and with a 50 percentage point increase in the number of students taking and passing the tests.

Brown and Choi (2015) employed a potential outcomes modeling approach to estimate the causal effect of CRP on three cohorts of schools, estimating effects of the program in an over-three-year period relative to a control group. They found significant positive effects in the first year of the adoption of CRP at program schools in terms of taking AP exams and also passing the exams relative to other schools. These effects persisted into the second and third years, with an overall increase of approximately 60% in the total number of students passing AP tests in targeted subjects.

Study Design and Research Questions

The evaluation of CRP under the i3 validation grant consists of two parts: (1) assessment of the program's impact on selected student AP exam outcomes and (2) assessment of the fidelity of implementation of CRP. The evaluation included three cohorts of schools that implemented CRP in Colorado and Indiana, where "school cohort" was defined by the year the schools began implementation, with the first cohort of schools (18 schools) beginning the program in the 2012–13 school year, the second cohort (21 schools) in 2013–14, and the third cohort (19 schools) in 2014–15. The impact evaluation used a CITS design in which schools that NMSI had recruited for the program in each state were matched to other public schools in the state based on observable characteristics of the schools, including prior performance on AP tests.

The CITS design measures impact as difference in trend between a treatment group and a comparison group over time following adoption of a program such as CRP. Within each state, we selected a set of comparison schools that were deemed comparable in terms of observed variables to those schools that adopted CRP. The variables used in matching included AP test outcomes (passing and testing) at the school level before schools adopted the program, along with characteristics of the schools (i.e., enrollment, share of minority enrollment, and economic disadvantage). Schools were matched on a cohort-by-cohort basis so that selected schools were as comparable as possible at the time that CRP schools adopted the program.

The specific research questions for the evaluation are as follows:

1. What were the impacts of CRP on the likelihood that students in the 10th through 12th grades within a school took and passed AP exams in targeted subjects (mathematics, science, and English) in the two states?
2. What were the impacts of CRP on the likelihood that students in the 10th through 12th grades within a school passed AP exams in targeted subjects (mathematics, science, and English) in the two states?
3. Were all components of the program implemented with fidelity in the two states?
4. What parts of the program were most useful from the standpoint of participants?

The sample of schools used to address the first two questions (the impact study) included all schools that adopted CRP under the grant and a matched sample of schools selected as comparison schools in the respective states. The implementation study primarily focused on CRP schools and used summary measures of implementation that were developed to complete the fidelity matrix required to report data to the NEi3. In addition to data on the fidelity of implementation, we collected information on how the program was implemented through surveys to individuals who coordinated these programs within schools; this provided inputs into the fidelity matrix, along with data generated through program records (e.g., attendance at summer institutes). We also administered surveys to AP teachers in the schools and a sample of students in their classes to gain their perspective on the parts of the program that were the most useful. In addition, we also fielded surveys to comparison schools; only about half of the comparison schools provided information. Surveys were sent to comparison schools to obtain a sense of the "business as usual" at these schools, to examine what types of supports were offered.

Sample Description

To use a CITS model, it is necessary to identify a sample of schools that are as comparable as possible to program (or treatment) schools. The treatment schools for this evaluation were selected by NMSI using standard protocols for recruitment, including the willingness of schools to meet specified requirements for participation. In contrast, comparison schools had not been recruited by NMSI as part of the i3 grant, so it was not possible to conduct a randomized control trial that would assign some recruited schools to a treatment group and the rest to a control group that either would not receive treatment or would receive it later.[1] Although this study did not randomly assign schools to groups, the CITS design implicitly controls for differences in the baseline mean between the treatment and the comparison group. The CITS design has been shown to generate estimates that are similar to the RCT benchmark (Somers, Zhu, Jacob, & Bloom, 2013).

The AIR evaluation team identified and recruited a group of comparison schools similar to the treatment schools in each of the three cohorts in each state by using the statistical matching approach of Mahalanobis distance matching, which identifies potential comparison schools for each treatment school based on the overall "closeness" to treatment schools in terms of a summary distance measure defined in terms of differences in observed variables (Stuart, 2010).

Data on school characteristics used for selecting matched comparison schools and for creating model variables came from the Common Core of Data (CCD) Public School Universe Survey data, collected annually by the National Center for Education Statistics (NCES). The CCD contains school demographic characteristics and enrollment data for public elementary and secondary schools. The data included school name and location, number of students enrolled in each grade level offered at the school, race/ethnicity composition at the school, and number of students eligible for the free and reduced-price lunch program. CCD data were linked with the College Board AP exam data using school name and school location (such as the high school

[1] NMSI received an i3 scale-up grant in 2015 to conduct a randomized controlled trial (RCT) in which recruited schools were randomly assigned to a treatment and a control group that would receive treatment with a 1-year delay.

address or zip code) for the corresponding year of the AP exam data. For example, AP exam scores from spring 2014 were linked with CCD to the 2013–14 school year.

The data used to create outcome variables for the impact study were provided by the College Board. These data included student-level records for each AP test student during the school year or the summer after the school year. The outcome measures used in the analysis were the share of students in Grades 10–12 in a school year who had (1) taken an AP test in a targeted subject area or who had (2) taken and passed an AP test in a targeted subject area. We only included students in Grades 10–12 because in general only students in these grade levels take AP courses. If a school had 1,000 students and 100 took an AP test and 50 passed these tests, the school-level value of the test-taking variable would be 0.1 (100/1,000) and the school-level value of the test-passing variable would be 0.05 (50/1,000).

To create the outcome variables, AP exams were grouped into three subject areas: math, science, and English. AP exams in math include exams in Calculus AB, Calculus BC, Computer Science A, and Statistics. AP exams in science include exams in Biology, Chemistry, Environmental Science, Physics B, Physics C: Electricity & Magnetism, and Physics C: Mechanics (Physics 1 and Physics 2 were introduced in the 2014–15 school year). AP exams in English include exams in English Language & Composition and English Literature & Composition.

The overall measures of program impact were based on tests across all three areas (math, science, and English), but in analysis we also reported findings for math alone, science alone, math and science together, and English alone. The primary confirmatory variable in the analysis is the share of students in a school who pass an AP test in any of the targeted subjects, in that this variable is a general measure of whether students are college ready in terms of having passed at least one test in these subjects. Passing rates by subject area provide more-specific information on the topics in which students are prepared. The variables related to test taking provide an overall measure of participation in AP courses (regardless of whether students pass these tests) and provide an indication of the exposure of students to rigorous coursework provided through AP courses.

Comparison schools were selected from public high schools not currently participating in CRP or otherwise identified as participating in CRP in a later year. The matching variables included school-level averages of AP exam taking and passing rates across the 3 baseline years based on data provided by the College Board (e.g., for Cohort 1 schools, the average AP exam taking and passing rates in 2009–10, 2010–11, and 2011–12 were used). Additional matching variables included three measures of school characteristics from the most recent baseline year—percentage of White students, percentage of students eligible for free or reduced-price lunch, and total Grades 10–12 enrollment—which were based on the CCD collected by NCES.

Matching was conducted separately within each state and for each school cohort as the study progressed. However, in the report, we present summaries of the baseline school characteristics for CRP schools and comparison schools with schools from Colorado and Indiana combined. Tables 1 through 3 show the baseline school characteristics separately for the three cohorts of schools. Table 4 shows the results for the overall sample. The balance of the overall sample is important because some impact analyses relied on data pooled across multiple cohorts.

The last column in each table shows the standardized group differences between CRP schools and matched comparison schools, which are measures of the baseline balance of the sample. The standardized group difference in Grades 10–12 enrollment was calculated as Hedge's *g* (group mean difference divided by pooled standard deviation); the standardized difference on the other matching variables (which were binary) were computed based on the Cox Index (logged odds ratio divided by 1.65).[2] A small standardized group difference (e.g., 0.25 or smaller) indicates that the CRP schools and the comparison schools were similar on the matching variable.

Table 1. Baseline Characteristics of CRP and Comparison Schools (CO and IN): Cohort 1

School Baseline Characteristics	Mean of CRP Schools (*N* = 18)	Mean of Matched Comparison Schools (*N* = 18)	Standardized Group Difference After Matching
% White (2011–12)	49.36	52.08	–0.07
% eligible for free or reduced-price lunch (2011–12)	53.21	48.56	0.11
Grades 10–12 enrollment (2011–12)	1,602	1,563	0.07
% taking AP exam in English, mathematics, or science (average across 2009–10, 2010–11, & 2011–12)	10.48	9.95	0.04
% passing AP exam in English, mathematics, or science (average across 2009–10, 2010–11, & 2011–12)	4.12	4.23	–0.02

Table 2. Baseline Characteristics of CRP and Comparison Schools (CO and IN): Cohort 2

School Baseline Characteristics	Mean of CRP Schools (*N* = 21)	Mean of Matched Comparison Schools (*N* = 21)	Standardized Group Difference After Matching
% White (2012–13)	49.63	58.80	–0.22
% eligible for free or reduced-price lunch (2012–13)	50.81	46.14	0.11
Grades 10–12 enrollment (2012–13)	1,604	1,562	0.05
% taking AP exam in English, mathematics, or science (average across 2010–11, 2011–12, & 2012–13)	10.77	10.29	0.03
% passing AP exam in English, mathematics, or science (average across 2010–11, 2011–12, & 2012–13)	4.87	4.61	0.03

[2] Differences in AP exam taking/passing rates after matching presented in this report vary slightly from the values reported in the "NEi3 Data Collection Templates for Reporting Effects and Fidelity of Implementation Findings." In the data collection tables, average values on the baseline characteristics were based on the most recent baseline year for the NEi3 tables instead of the averages across the 3 baseline years used to select schools and for balance check. We calculated the balance in AP exam taking/passing rates based on the averages across the 3 baseline years because it is more consistent with the model specification for the impact analysis.

Table 3. Baseline Characteristics of CRP and Comparison Schools (CO and IN): Cohort 3

School Baseline Characteristics	Mean of CRP Schools (*N* = 19)	Mean of Matched Comparison Schools (*N* = 19)	Standardized Group Difference After Matching
% White (2013–14)	49.36	52.08	–0.07
% eligible for free or reduced-price lunch (2013–14)	53.21	48.56	0.11
Grades 10–12 enrollment (2013–14)	875	820	0.11
% taking AP exam in English, mathematics, or science (average across 2011–12, 2012–13, & 2013–14)	13.68	12.70	0.05
% passing AP exam in English, mathematics, or science (average across 2011–12, 2012–13, & 2013–14)	4.25	4.59	–0.05

Table 4. Baseline Characteristics of CRP and Comparison Schools (CO and IN): All Three Cohorts

School Baseline Characteristics	Mean of CRP Schools (*N* = 58)	Mean of Matched Comparison Schools (*N* = 58)	Standardized Group Difference After Matching
% White	53.35	52.90	0.02
% eligible for free or reduced-price lunch	52.53	50.02	0.13
Grades 10–12 enrollment	1,365	1319	0.06
% taking AP exam in English, mathematics, or science (average across 3 baseline years)	12.48	11.05	0.24
% passing AP exam in English, mathematics, or science (average across 3 baseline years)	4.53	4.20	0.11

Tables 1 through 3 show that there was some variation across cohorts in variables used in matching, both for the program schools and also for the schools selected as comparison schools. However, tables show that within cohorts, the absolute value of the standardized differences between program and comparison schools were all below 0.25, indicating that groups were similar across the variables used for matching.

Estimation Approach (Impact Models)

To estimate the impact of CRP, we used a two-level baseline mean CITS model that controlled for the mean outcomes at schools across the 3 baseline years. The first cohort of schools implemented the program in the 2012–13 school year and was followed through 3 years of program implementation. For this first cohort, we computed effects after 1, 2, and 3 years of program implementation. The sample was augmented the next year with a second cohort, which allowed us to compute both a first-year effect and a second-year effect over the 2 years that they

received support under the grant. Finally, for the 2014–15 school year we added a third cohort of schools for which we could compute only a 1-year effect.

In addition to the effects estimated for individual school cohorts, it was also possible to pool 1-year effects across all three cohorts. In addition, we were able to combine 2-year effects across the first two cohorts. An advantage of effects pooled across multiple cohorts is that they are based on larger sample sizes and thus estimated with greater precision.

Impact Models for the First School Cohort

The impact estimate of particular importance for this study is the effect after 3 years of program implementation, which could be estimated only for the first cohort in this study. This represents the full period over which NMSI implements the program in a school. In this section, we present the two-level linear model used to estimate the 3-year impact for the first cohort, where the AP exam taking/passing rates in different years (i.e., 3 baseline years and the third follow-up year) were nested within schools. The estimation of the 1-year and 2-year impacts for this first cohort of schools was based on a similar model, the only difference being that the 1-year impact model included the first follow-up year and the 2-year impact model included the second follow-up year in the model. The year-specific impacts for the second and third school cohorts were estimated using similar models.

Level 1 (year level):

$$Y_{ij} = \beta_{0j} + \beta_{1j} FY3_{ij} + r_{ij}$$

where

- Y_{ij} is the outcome (e.g., the percentage of Grades 10–12 students who passed AP exams in math, science, or English) in year *i* for school *j*
- $FY3_{ij}$ is a dummy variable coded 1 for the third follow-up year (defined the same way for both CRP schools and comparison schools) and 0 for baseline years

Level 2 (school level):

$$\beta_{0j} = \gamma_{00} + \gamma_{01} TREAT_j + \gamma_{02} MEMBER11_j + \gamma_{03} FRPL11_j + \gamma_{04} WHITE11_j + \gamma_{05} SUBURB11_j + \gamma_{06} RURAL11_j + \gamma_{07} CO_j + U_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11} TREAT_j + \gamma_{12} MEMBER11_j + \gamma_{13} FRPL11_j + \gamma_{14} WHITE11_j + \gamma_{15} SUBURB11_j + \gamma_{16} RURAL11_j + \gamma_{17} CO_j + U_{1j}$$

where

- $TREAT_j$ is a dummy indicator for treatment status, coded 1 for CRP schools and 0 for comparison schools
- $MEMBER11_j$ is the total Grades 10–12 enrollment in school *j* in 2011–12 (the most recent baseline year for Cohort 1),
- $FRPL11_j$ is the percentage of students eligible for free or reduced-price lunch in 2011–12 in school *j*

- *WHITE11* $_j$ is the percentage of White students in 2011–12 in school *j*
- *SUBURB11* $_j$ is a dummy indicator for whether school *j* was located in a suburban area in 2011–12
- *RURAL11* $_j$ is a dummy indicator for whether school *j* was located in a rural area in 2011–12
- *CO* $_j$ is a dummy indicator for state (1 = Colorado, 0 = Indiana)

The Level 2 coefficient γ_{11} is the estimate of primary interest in this model, which represents the difference between treatment schools and comparison schools in the deviation in the outcome from baseline to the third follow-up year.

Pooled 2-Year Impact Model for Cohorts 1 and 2 Schools

We estimated the impact of CRP after 2 years of implementation based on data pooled across the first and second cohorts of schools using the following model:

Level 1 Model (year level):

$$Y_{ij} = \beta_{0j} + \beta_{1j}FY2_{ij} + r_{ij}$$

where $FY2_{ij}$ is a dummy variable indicating whether the year was the second year after the adoption of CRP (i.e., "the second follow-up year," defined the same way for both CRP schools and comparison schools): *FY2* = 1 for the second follow-up year and 0 for baseline years.

Level 2 Model (school level):

$$\beta_{0j} = \gamma_{00} + \gamma_{01}TREAT_j + \gamma_{02}MEMBER_j + \gamma_{03}FRPL_j + \gamma_{04}WHITE_j + \gamma_{05}SUBURB_j + \gamma_{06}RURAL_j + \gamma_{07}CO_j + \gamma_{08}COHORT2_j + U_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}TREAT_j + \gamma_{12}MEMBER_j + \gamma_{13}FRPL_j + \gamma_{14}WHITE_j + \gamma_{15}SUBURB_j + \gamma_{16}RURAL_j + \gamma_{17}CO_j + \gamma_{18}COHORT2_j + U_{1j}$$

where $TREAT_j$ is a dummy indicator for treatment status; $MEMBER_j$, $FRPL_j$, $WHITE_j$, $SUBURB_j$, and $RURAL_j$ are school characteristics at the most recent baseline year (2011–12 for Cohort 1 schools, 2012–13 for Cohort 2 schools); CO is an indicator for state (1 = Colorado, 0 = Indiana); and *COHORT2* is an indicator for school cohort (1 = Cohort 2, 0 = Cohort 1).

The Level 2 coefficient γ_{11} is the estimate of primary interest in this model, which represents the overall difference between treatment schools and comparison schools pooled across both cohorts in the deviation in the outcome from baseline to the second follow-up year.

Pooled 1-Year Impact Model Across All Three Cohorts

We estimated the overall impact of the program after 1 year of implementation across all three cohorts using the following model:

Level 1 Model (year level):

$$Y_{ij} = \beta_{0j} + \beta_{1j}FY1_{ij} + r_{ij}$$

where $FY1_{ij}$ is a dummy variable that coded each year as 0 or 1, indicating whether the year was the first year after the adoption of CRP (i.e., "the first follow-up year," defined the same way for both CRP schools and comparison schools): $FY1_{ij}$ = 1 for the first follow-up year and 0 for baseline years.

Level 2 Model (school level):

$$\beta_{0j} = \gamma_{00} + \gamma_{01}TREAT_j + \gamma_{02}MEMBER_j + \gamma_{03}FRPL_j + \gamma_{04}WHITE_j + \gamma_{05}SUBURB_j + \gamma_{06}RURAL_j + \gamma_{07}CO_j + \gamma_{08}COHORT2_j + \gamma_{09}COHORT3_j + U_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}TREAT_j + \gamma_{12}MEMBER_j + \gamma_{13}FRPL_j + \gamma_{14}WHITE_j + \gamma_{15}SUBURB_j + \gamma_{16}RURAL_j + \gamma_{17}CO_j + \gamma_{18}COHORT2_j + \gamma_{19}COHORT3_j + U_{1j}$$

where $TREAT_j$ is a dummy indicator for treatment status; $MEMBER_j$ (Grades 10–12 enrollment), $FRPL_j$ (percent of students eligible for free or reduced-price lunch), $WHITE_j$ (percent of White students), $SUBURB_j$ (whether or not a school is located in a suburban area, with 1 indicating a suburban school and 0 indicating a nonsuburban school), and $RURAL_j$ (a dummy indicator indicating whether or not a school is located in a rural area, with 1 indicating a rural school and 0 indicating a suburban or rural school). *CO* is an indicator for state (1 = Colorado, 0 = Indiana). *COHORT2* is an indicator for Cohort 2 schools (1 = Cohort 2 schools, 0 = Cohorts 1 and 3 schools). *COHORT3* is an indicator for Cohort 3 schools (1 = Cohort 3 schools, 0 = Cohorts 1 and 2 schools).

The Level 2 coefficient γ_{11} is the estimate of primary interest in this model, which represents the overall difference between treatment schools and comparison schools across all three cohorts in the deviation in the outcome from baseline to the first follow-up year.

Impact Findings

In this section, we first present findings for the 3-year impacts for the first cohort of schools. The 3-year impacts for the first cohort are the key confirmatory findings for the evaluation, in that these findings show what impact the 3-year program had after the period of full implementation. We then present findings about 1-year impacts pooled across all three cohorts and 2-year impacts pooled across the first two cohorts. Additional year-specific impact findings for individual cohorts are provided in the appendix.

In addition to findings for the key outcome measure (i.e., the percentage of Grades 10–12 students passing at least one AP test in the targeted subjects of math, science, or English), we also present findings for the AP test passing rate in each of the three subjects separately and in math and science combined. Moreover, we present results for the AP test-taking rate, a measure of exposure to AP coursework. For both test-taking and test-passing outcomes, our findings show that the largest impacts were in math and science courses—i.e., results combining the three subject areas covered by CRP were not dominated by AP outcomes in English.

Three-Year Impacts for Cohort 1 Schools

Table 5 presents findings for the 3-year impacts of CRP for Cohort 1 schools in Colorado and Indiana on two sets of AP-related outcomes: percentage of students in a school taking an AP exam in targeted subjects and percentage of students passing an AP exam in these subjects. The table shows that the percentage of students taking an AP exam in targeted subjects and the percentage of students passing an AP exam increased for the treatment schools across subject areas but decreased for the comparison schools from baseline to the third year of implementation in all subject areas except science (where the AP passing rate increased for both treatment and comparison schools).

The percentage of Grades 10–12 students who took an AP exam in math, science, or English during the third year of CRP implementation, for example, increased by 8.64 percentage points from the average of the 3 baseline years for the treatment schools but decreased by 2.13 percentage points for the comparison schools over the same time period. The difference of 10.77 percentage points was statistically significant at the 0.001 level. In terms of the percentage of students passing AP exams in these areas, there was a 3.97 percentage point difference between treatment and comparison schools, which was statistically significant at the 0.001 level.

Table 5. Three-Year Impacts of CRP on Percentage of Students Taking AP Exam and Percentage of Students Passing AP Exam in Cohort 1 Schools in Colorado and Indiana, by Subject

Outcome	Average Deviation From Baseline Mean		Estimated Group Difference	Standard Error of Difference	P-Value
	Treatment Group	Comparison Group			
Percent Taking AP Exam					
Math/science/English	8.64	–2.13	10.77	1.69	0.000***
Math/science	7.06	–0.99	8.05	1.33	0.000***
Math	3.66	–0.56	4.22	0.72	0.000***
Science	5.99	–0.08	6.07	1.15	0.000***
English	3.97	–1.63	5.60	1.41	0.000***
Percent Passing AP Exam					
Math/science/English	3.12	–0.85	3.97	0.72	0.000***
Math/science	3.17	–0.31	3.48	0.50	0.000***
Math	1.76	–0.17	1.93	0.42	0.000***
Science	2.09	0.11	1.98	0.31	0.000***
English	1.01	–0.59	1.60	0.64	0.013*

Notes. Number of schools = 36 (18 treatment, 18 comparison).

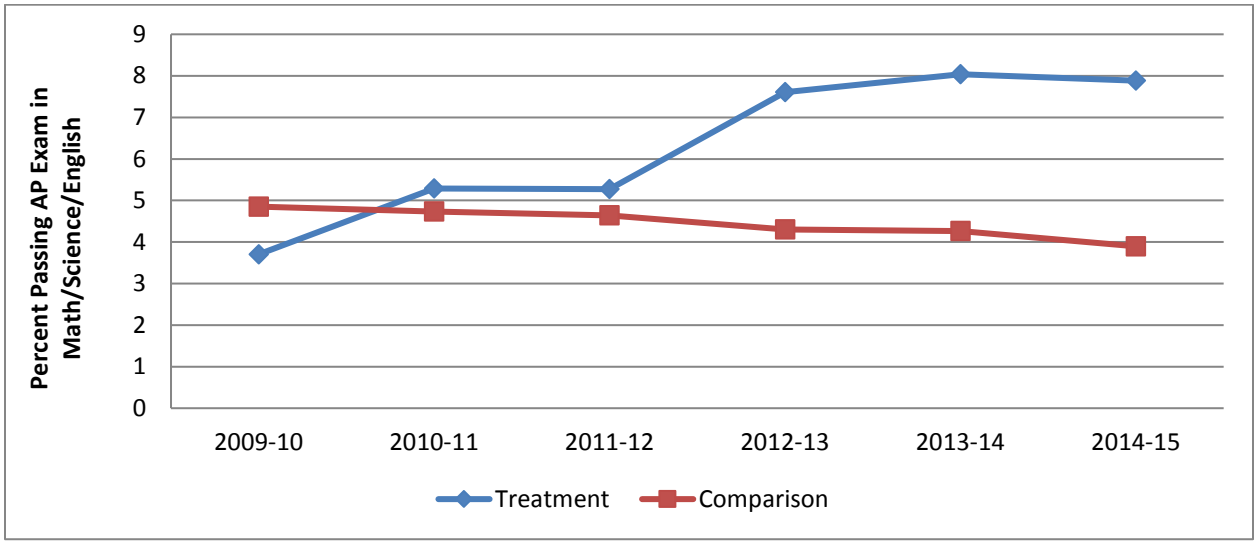
Average deviation from baseline mean for the treatment group is the unadjusted average deviation across treatment schools; average deviation for the comparison group was computed by subtracting the group difference estimate based on the impact model from the unadjusted average deviation for the treatment group.

P-values are based on two-tailed *t* tests: *p < .05; **p < .01; ***p < .001.

Figure 1 illustrates the difference between Cohort 1 treatment and comparison schools in both states in their change over time in the most important outcome for this study—the school-level

percentage of students passing AP exam in math, science, or English.[3] The figure shows clearly that the AP exam passing rate for the treatment schools increased substantially from the baseline period (2009–10 to 2011–12) to the third year of implementation (2014–15) (by 3.12 percentage points), whereas the AP exam passing rate for the comparison schools decreased somewhat (by 0.85 percentage points) over the same time period. The difference (3.97 percentage points) was statistically significant at the 0.001 level. For this cohort, it appears that the impact of the program was largely realized in the first year of implementation and maintained into the second and third years.

Figure 1. Percentage of Students Passing AP Exam in Math/Science/English From 2009–10 to 2014–15 in Colorado and Indiana, by Study Group



Notes. Number of schools = 36 (18 treatment, 18 comparison).

The treatment group means for all years and the comparison group means for baseline years were unadjusted means. The means for the follow-up years for the comparison group were adjusted means based on the estimated difference between the treatment and comparison groups in the deviation from baseline to each follow-up year.

Pooled 2-Year Impacts for Cohorts 1 and 2 Schools

Table 6 presents the results for the 2-year impacts of CRP on AP performance outcomes based on data pooled across the first two cohorts of schools in Colorado and Indiana. It shows that the pooled 2-year impacts of CRP were positive and significant across all the AP outcomes examined.

[3] The estimates of 1-year and 2-year impacts for Cohort 1 are presented in the appendix.

Table 6. Pooled 2-Year Impacts of CRP on Percentage of Students Taking AP Exam and Percentage of Students Passing AP Exam in Cohorts 1 and 2 Schools in Colorado and Indiana, by Subject

Outcome	Average Deviation From Baseline Mean		Estimated Group Difference	Standard Error of Difference	P-Value
	Treatment Group	Comparison Group			
Percent Taking AP Exam					
Math/science/English	8.23	–0.87	9.10	1.12	0.000***
Math/science	6.33	–0.94	7.27	0.95	0.000***
Math	3.51	–0.66	4.17	0.56	0.000***
Science	4.77	–0.17	4.94	0.81	0.000***
English	4.84	–0.16	5.00	0.92	0.000***
Percent Passing AP Exam					
Math/science/English	3.46	–0.11	3.57	0.53	0.000***
Math/science	2.96	0.04	2.92	0.41	0.000***
Math	1.90	–0.11	2.01	0.32	0.000***
Science	1.87	0.15	1.72	0.27	0.000***
English	1.68	–0.14	1.82	0.41	0.000***

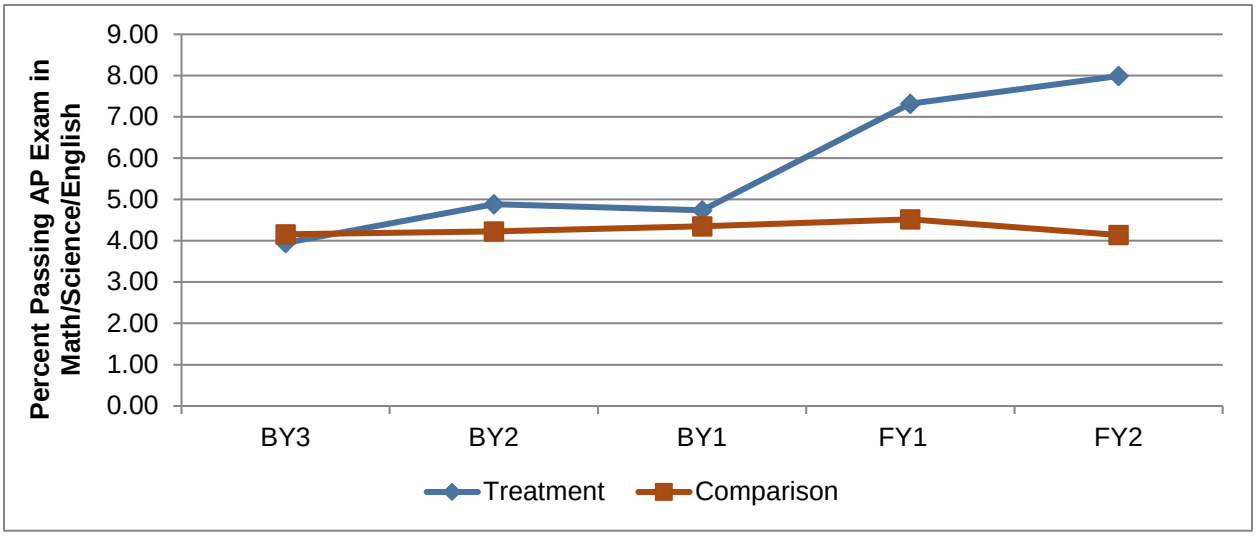
Notes. Number of schools = 78 (39 treatment, 39 comparison).

Average deviation from baseline mean for the treatment group is the unadjusted average deviation across treatment schools; average deviation for the comparison group was computed by subtracting the estimated group difference from the unadjusted average deviation for the treatment group.

P-values are based on two-tailed *t* tests: *p < .05; **p < .01; ***p < .001.

Figure 2 illustrates the impact of the program on the percentage of students passing AP exam in math, science, or English in schools from both Cohorts 1 and 2. It shows that the AP exam passing rate was largely stable in both treatment schools and comparison schools during the baseline years, then increased substantially in treatment schools but remained stable in comparison schools during the first two follow-up years. The difference between the two study groups in the change in the AP exam passing rate from baseline years to the second implementation year (3.57 percentages points) was statistically significant at the .001 level. These findings suggest that the impact of the CRP program persisted through the second implementation year based on data pooled across both cohorts.

Figure 2. Percentage of Students Passing AP Exam in Math/Science/English From 3 Baseline Years (BY1, BY2, and BY3) to First Two Follow-up Years (FY1 and FY2) in Schools in Cohorts 1 and 2 in Colorado and Indiana, by Study Group



Notes. Number of schools = 78 (39 treatment, 39 comparison).

The treatment group means for all years and the comparison group means for baseline years were unadjusted means. The means for the follow-up years for the comparison group were adjusted means based on the estimated difference between the treatment and comparison groups in the deviation from baseline to each follow-up year.

Pooled 1-Year Impacts Across All Three Cohorts

Table 7 presents the results for pooled 1-year impacts of CRP on AP performance outcomes across three cohorts of schools in Colorado and Indiana. It shows that CRP's impacts on all the outcomes examined were positive and statistically significant.

Table 7. Pooled 1-Year Impacts of CRP on Percentage of Students Taking AP Exam and Percentage of Students Passing AP Exam in Schools Across All Cohorts in Colorado and Indiana, by Subject

Outcome	Average Deviation From Baseline Mean		Estimated Group Difference	Standard Error of Difference	P-Value
	Treatment Group	Comparison Group			
Percent Taking AP Exam					
Math/science/English	7.42	0.17	7.25	0.98	0.000***
Math/science	5.33	–0.11	5.44	0.73	0.000***
Math	2.48	0.04	2.44	0.49	0.000***
Science	4.38	0.02	4.36	0.64	0.000***
English	4.66	0.51	4.15	0.84	0.000***
Percent Passing AP Exam					
Math/science/English	2.98	0.23	2.75	0.41	0.000***
Math/science	2.20	0.24	1.96	0.32	0.000***
Math	1.15	0.17	0.98	0.23	0.000***

Outcome	Average Deviation From Baseline Mean		Estimated Group Difference	Standard Error of Difference	P-Value
	Treatment Group	Comparison Group			
Science	1.68	0.22	1.46	0.24	0.000***
English	1.65	0.12	1.53	0.35	0.000***

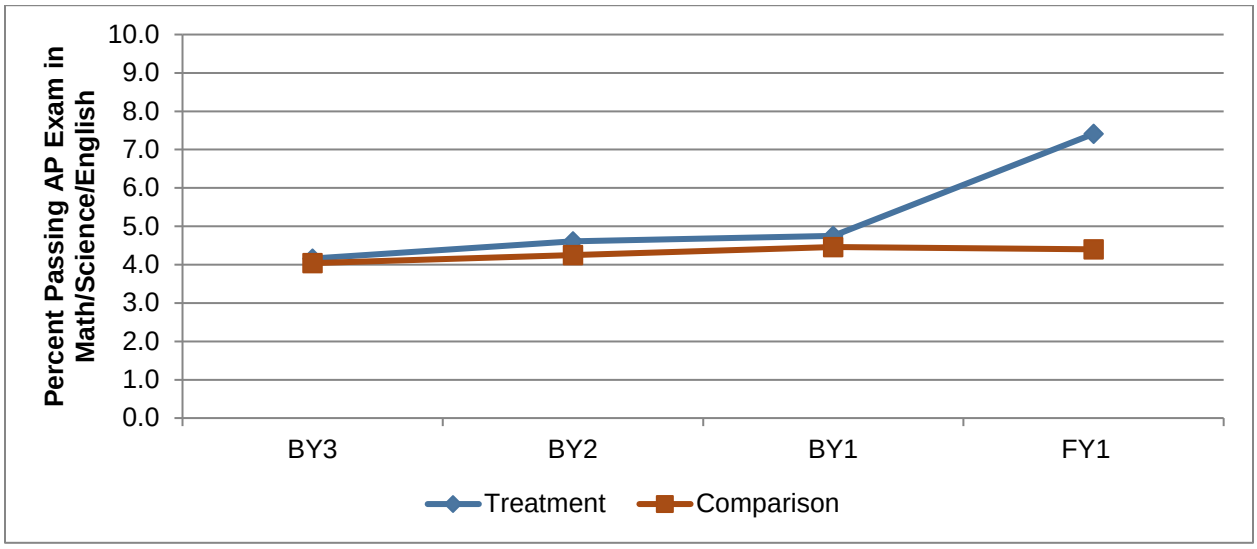
Notes. Number of schools = 116 (58 treatment, 58 comparison).

Average deviation from baseline mean for the treatment group is the unadjusted average deviation across treatment schools; average deviation for the comparison group was computed by subtracting the estimated group difference from the unadjusted average deviation for the treatment group.

P-values are based on two-tailed *t* tests: *p < .05; **p < .01; ***p < .001.

Figure 3 depicts the change in the percentage of students passing the AP exam in math, science, or English from the baseline years to the first follow-up year in treatment schools and the corresponding change in comparison schools across all three school cohorts. It shows that the AP exam passing rate remained stable from the baseline years to the first follow-up year in comparison schools but increased substantially in treatment schools. The difference in the change between the two groups of schools (2.75 percentage points) was statistically significant at the .001 level.

Figure 3. Change in Percentage of Students Passing AP Exam in Math/Science/English From 3 Baseline Years (BY1, BY2, and BY3) to First Follow-up Year (FY1) for Schools in All Cohorts in Colorado and Indiana, by Study Group



Notes. Number of schools = 116 (58 treatment, 58 comparison).

The treatment group means for all years and the comparison group means for baseline years were unadjusted means. The means for the follow-up years for the comparison group were adjusted means based on the estimated difference between the treatment and comparison groups in the deviation from baseline to each follow-up year.

The impact findings presented here show that the adoption of CRP was consistently associated with gains in both the AP exam-taking rate and the passing rate in treatment schools over time from the baseline years, while these rates for comparison schools remained largely unchanged over the same time period. Findings about CRP's impact on the percentage of students passing

AP exams are similar to those of earlier research, cited previously, which found that the adoption of the program was associated with increases in the number of students passing AP tests of 45% (Jackson, 2010) relative to comparison groups for an earlier version of the program to between 50% for Holtzman (2011) covering CRP in six states and 60% for Brown and Choi (2015) covering three recent cohorts of schools across the nation.

Implementation Findings

We used two different approaches to examine the implementation of the CRP: a "fidelity matrix" approach required by NEi3 and a survey-based approach. The fidelity matrix approach collects information on program implementation in terms of observable indicators related to specific elements of a program. CRP has four components, and each has between three and five indicators of program performance (shown in Table 8) that were used to assess fidelity of implementation based on performance.

Table 8. Key Components and Indicators of CRP

Key Component of CRP	Program Elements/Indicators
1. Program management	Reports on problems provided on time Student-level data provided by school Performance feedback provided by NMSI School-level data provided by school
2. Teacher supports	Lead teachers identified Team meetings held Subject-matter experts identified Training: summer institute attendance Training: Saturday study sessions attendance
3. Student supports	Exam fees paid by NMSI Equipment and supplies provided as agreed Enrollment targets achieved
4. Awards/incentives provided	Administrator awards paid Teacher awards paid Student awards paid

Under the fidelity matrix approach, the evaluator sets thresholds of performance for each indicator to establish whether an element of the program was implemented with fidelity at a school, and then results are combined across schools to determine if the element was implemented with fidelity at 80% of schools. In some cases implementation could be measured on a yes/no basis (all elements of Components 1, 3, and 4 as well as the identification of lead teachers and state subject-matter experts under Component 2). These elements were assessed as being implemented with fidelity if 80% of schools implemented them as planned.

For those program elements that involved a number of staff participating in an activity (e.g., teachers attending summer institutes or Saturday study sessions under Component 2), a school was considered to have implemented the program with fidelity if 80% of identified staff in the school participated for the required number of sessions (e.g., 4 days of the summer institute; 3 Saturday sessions). These elements were considered to have been implemented with fidelity

across a program school if 80% of schools met the target (e.g., 80% of teachers attending all meetings/sessions).

The evaluation also collected information from a series of annual surveys administered to individuals at CRP schools tasked with coordinating the program within their schools, to all AP teachers at these schools, and to a sample of students in AP courses. These surveys were designed to gather information on participation in activities associated with the program and also asked respondents how useful they thought various program supports were. As part of the survey process, we also interviewed the individuals responsible for administering the program at the schools to obtain additional information on how the program was implemented and to understand potential barriers to implementation.

Fidelity Matrix Results

The fidelity matrix approach is relatively stringent, in that it sets targets for performance for each element of the program and requires that 80% of schools meet targets to be considered as implementing the program with fidelity. By the definitions used in the fidelity matrix, CRP was not implemented with full fidelity outside of Component 1 (setting up program structure and providing data) and Component 4 (making financial rewards). This was a consistent result across cohorts and across years. Overall, there were some elements of the program that schools had difficulty implementing, mostly related to attendance of teachers at the required number of vertical team meetings or teachers and students at Saturday study sessions.

Within Component 1 (program management), the regional director conducted all visits and monitoring activities and the NSAs submitted all required student-level data and annual performance results to NMSI. For Component 4 (awards/incentives), the NSAs dispersed all awards to the administrators, teachers, and students based on AP test results.

Under Component 2, the lead teachers and NSA content leads in each state fulfilled their roles as outlined by NMSI and the NSAs. However, for the summer training, vertical team meetings, and Saturday sessions—given that teachers found it difficult to attend sessions outside of the regularly scheduled school hours due to family or other responsibilities (such as coaching)—most schools did not meet the targets for these elements, and as result they were reported as not being implemented with fidelity.

Under student supports (Component 3), two elements were implemented with fidelity across all program schools: paid exam fees and equipment and supplies. In contrast, fewer than 80% of schools were able to meet their targets set with NMSI for enrollment increases in AP classes.

Survey Results

The study team administered surveys in the spring of each year of CRP implementation to staff and students at both CRP schools and comparison schools. The surveys administered at CRP schools gathered information on the aspects of the program that teachers and students found useful. Additionally, surveys to lead teachers at CRP schools gathered information on whether the lead teachers engaged in activities required by the program. Surveys of teachers and students

in AP programs at comparison schools were shorter and primarily asked about the extent to which they received supports similar to those offered under the CRP.

At CRP schools, designated administrators were invited to participate; administrators at comparison schools who worked closely with the AP program were also invited to take the survey. Across the 3 years of the study, the response rate among administrators for CRP schools was over 90%. Similarly, in comparison schools the response rates of individuals having lead roles in administering activities related to AP programs were 85% across the 3 years of the study.

The student surveys were originally designed to be administered to a small sample of students—approximately 15 to 20 students per school who were taking AP math, science, or English courses—at both treatment and comparison schools. However, many schools decided that it would be more convenient to invite an entire AP class to participate instead of sampling students from each course. As a result, the number of students who responded to the survey at a participating school ranged from less than 10 to over 100.

In CRP schools, teachers and students responded to questions about the usefulness of supports offered in all 3 years of the program; in comparison schools, teachers and students responded to questions asking about the types of support offered to teachers and students participating in the AP program over the same time period. Table 9 shows the survey items that were asked of teachers and students about the supports they received.

Table 9. Survey Items on Teacher and Student Supports

Respondents	CRP/Comparison	Support	Item	Response Options
Teachers	CRP	Collaboration	How would you describe the usefulness of the collaboration with other AP math, science, and English teachers?	Extremely useful, somewhat useful, slightly useful, not at all useful
Teachers	CRP	Professional development	How would you describe the usefulness of the professional development training provided through CRP?	Extremely useful, somewhat useful, slightly useful, not at all useful
Teachers	CRP	Content specialist support	How would you describe the usefulness of the support provided by the content specialists?	Extremely useful, somewhat useful, slightly useful, not at all useful
Teachers	CRP	Incentives	How important are these incentives in encouraging your teaching of AP math, science, or English classes?	Extremely important, somewhat important, slightly important, not at all important

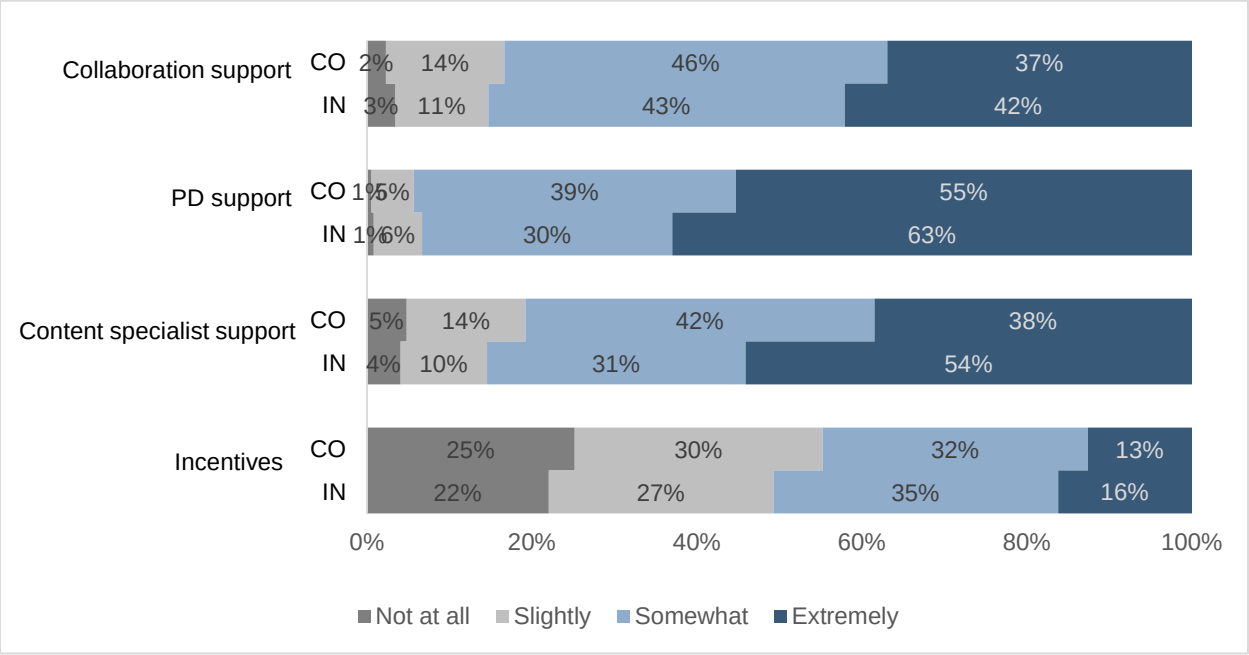
Respondents	CRP/Comparison	Support	Item	Response Options
Teachers	Comparison	Collaboration	Do you collaborate with other AP math, science, and English teachers (e.g., in a professional learning community [PLC] or in team meetings)?	Yes, no
Teachers	Comparison	Professional development	Did you receive additional content-specific professional development *specifically* for teaching AP classes?	Yes, no
Teachers	Comparison	Content specialist support	How often do you meet or communicate (virtually or in person) with a subject-matter expert or experts in your field?	Daily, weekly, monthly, other, not at all
Teachers	Comparison	Incentives	What incentives are offered to you as an AP math, science, or English teacher?	Financial incentives, additional PD opportunities, recertification points, leadership position, other, none
Students	CRP	Tutoring	How would you describe the usefulness of tutoring sessions?	Extremely useful, somewhat useful, slightly useful, not at all useful
Students	CRP	Tutoring/ group sessions	How would you describe the usefulness of AP student conferences/Saturday study sessions?	Extremely useful, somewhat useful, slightly useful, not at all useful
Students	CRP	Incentives	How important are the rewards in encouraging you to participate in AP math, science, and English classes?	Extremely important, somewhat important, slightly important, not at all important
Students	Comparison	Tutoring	Are tutoring sessions (e.g., one-on-one or small group academic help either during or outside of the school day) offered for any of your AP math, science, or English classes?	Yes, no

Respondents	CRP/Comparison	Support	Item	Response Options
Students	Comparison	Tutoring/ group sessions	Are group academic support sessions offered (e.g., study sessions or tutoring sessions with groups of students) for any of your AP math, science, or English courses?	Yes, no
Students	Comparison	Incentives	What are the rewards offered to encourage you to participate in AP math, science, and English courses?	Scholarship incentives, prizes, weighted grades, AP course exam fee is waived or supplemented, other, none, do not know

Teacher supports offered through CRP included collaboration support, professional development, support provided by the content specialists, and incentives. Across all 3 years of the study, 69% of program teachers who responded to the survey (67% in CO and 71% in IN) reported that they collaborated with other AP math, science, and English teachers outside of vertical team meetings that were part of CRP. Such collaborations could involve collaboration in professional learning communities or in team meetings that were part of teaching AP courses. Ninety percent of the teacher respondents (82% in CO and 98% in IN) reported that they participated in content-specific professional development offered through CRP. Three quarters of the teacher respondents (69% in CO and 81% in IN) reported that they met or communicated (virtually or in person) with a content specialist in their AP subject area.

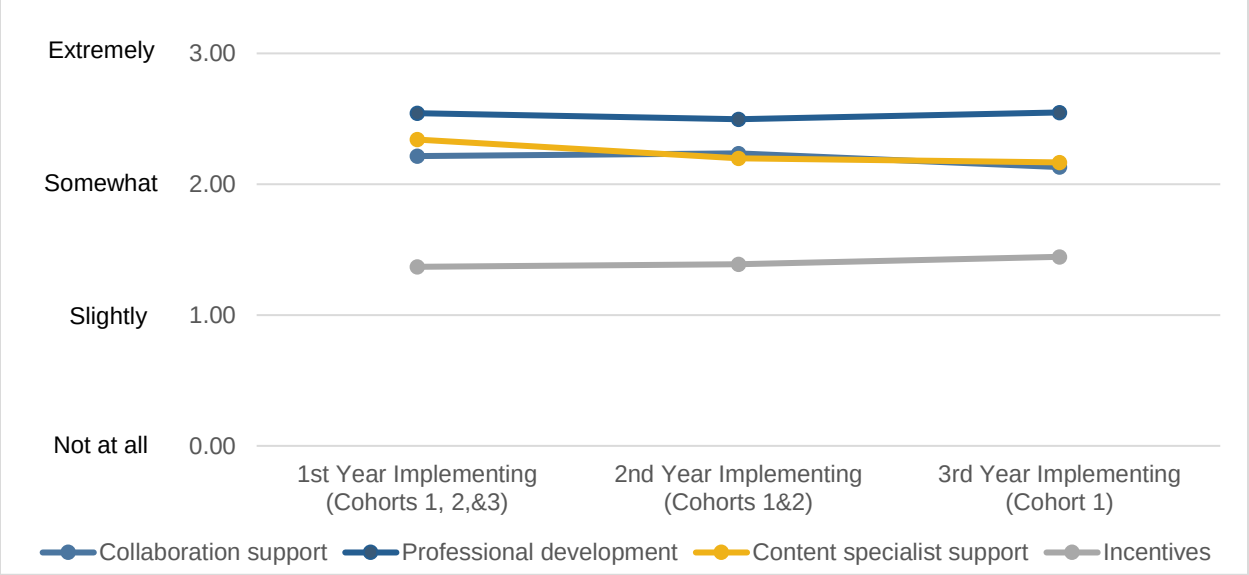
Figure 4 shows the usefulness of supports or the importance of incentives for program teachers who responded that they received these supports separately, by state. In general, teachers across both states found the supports useful. In particular, over 90% of teachers found the professional development supports either somewhat useful or extremely useful. The supports that teachers found to be less important were the incentives. About half of the teachers reported that incentives were either slightly important or not at all important.

Figure 4. CRP Teachers' Responses About the Usefulness of Supports, by State



The level of usefulness of program supports and the importance of the incentives as reported by teachers in CRP schools were similar over time. Figure 5 shows teachers' average responses to questions about the usefulness of the supports offered through the program in each year of implementation. On average, teachers reported that the collaboration, professional development, and content specialist supports were useful and that the level of usefulness of all these supports was very similar across all 3 years of implementation.

Figure 5. Level of Usefulness of Supports Reported by Teachers in CRP Schools, by Year of Implementation

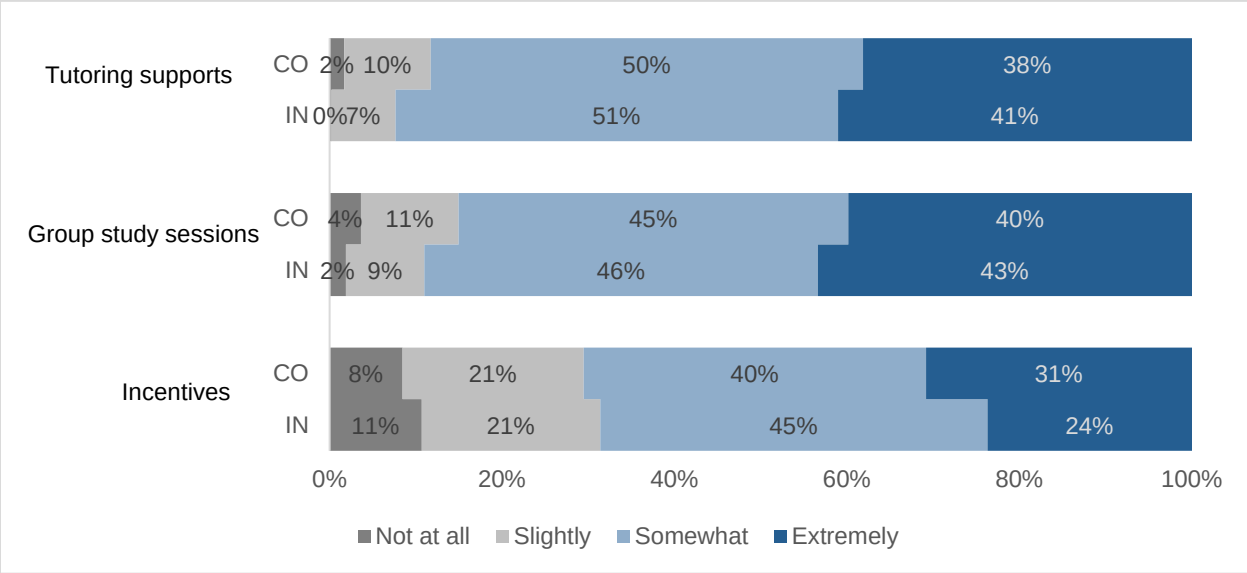


Teachers at comparison schools were offered some of the same types of supports for the AP program. Overall, about 50% of the teachers (40% in CO and 48% in IN) reported that they collaborated with other AP teachers, such as participating in a learning community. Sixty-eight percent of the teachers (70% in CO and 66% in IN) reported that they received additional content-specific professional development specifically on teaching AP classes. About half of the teachers (60% in CO and 44% in IN) reported that they met or communicated with a subject-matter expert. Over 80% of the teachers (84% in CO and 82% in IN) reported that no incentives were offered to them for teaching AP math, science, or English classes.

The study team asked students in CRP schools in the third year of the study—when all three school cohorts were implementing CRP—to report on the usefulness of the supports provided by the program. Students reported on the usefulness of the tutoring supports, the group academic sessions (which were Saturday study sessions in CO and AP student conferences in IN), and the incentives offered. Seventy-seven percent of the students responded that tutoring sessions were offered (66% in CO and 89% in IN). During the third year of the study, 84% of the students reported attending one or more Saturday study sessions, and this was similar across both states (83% in CO and 86% in IN).

Figure 6 shows the usefulness of supports or the importance of incentives reported by students in CRP schools separately, by state. Overall, students across both states found the supports useful. About 90% of the students reported that the tutoring supports and group study sessions were somewhat useful or extremely useful (over 85% in CO and over 89% in IN), and 70% of the students (71% in CO and 69% in IN) reported that the incentives were somewhat or extremely important.

Figure 6. Level of Usefulness of Supports in Third Year of Implementation Reported by Students in CRP Schools, by State



Students in comparison schools reported on similar supports in Year 3, including whether or not tutoring sessions and group academic supports were offered at their schools and whether incentives were provided. In Year 3, about 60% of the students in comparison schools reported

that tutoring sessions were offered, and 40% reported that group academic support sessions were offered. Further, 70% of students in comparison schools reported that some sort of incentive or reward was offered for taking AP classes, such as waiver of the AP course exam fee.

Discussion

The impact findings from the independent evaluation of NMSI's i3 validation grant show a consistent pattern across three cohorts of schools, where a significantly larger number of students in high schools that adopted the CRP took AP classes and, more importantly, more went on to pass AP tests, relative to similar schools not adopting the program. These results held for all three target subjects (math, science, and English) taken together (which is the primary outcome measure for the evaluation) or individual subjects. The significantly larger gains in CRP schools across subjects in the first year of implementation appeared to be sustained over time, in that the statistically significant effects in the first year of implementation continued into the second year for Cohorts 1 and 2, and into a third year for Cohort 1.

The evaluation shows that CRP was effective at those schools recruited by NMSI using their standard recruitment approaches, relative to other schools within the two states that had similar characteristics, including past history in the AP program. The results do not in themselves indicate that other schools (including the comparison schools in this evaluation) would necessarily achieve the same level of gains if they implemented the program, because schools must be motivated and willing to actively participate in the program, which requires the commitments of schools, teachers, and students.

The data collected for the fidelity matrix indicated that CRP was not fully implemented as intended largely because teachers were not able to participate in the requisite number of meetings for vertical teams (a collaboration activity) and because both teachers and students were not able to attend all Saturday study sessions. This led to the conclusion that two key components of the program—teacher supports and student supports—were not implemented with fidelity.

A general issue with the fidelity matrix approach required by the National Evaluation of the i3 program is that it requires a high degree of fidelity of implementation across most schools for the program element (e.g., teacher supports) to be rated as implemented with fidelity. For example, at the school level, high fidelity for implementation of summer institutes requires that 80% of all AP teachers at the school attend these institutes for the expected 4 days of the program. Even if all schools sent all teachers for this training, the fidelity matrix approach would find that this element of the program was not implemented with fidelity if two schools had, say, 75% of their teachers attending the institute for 3 days rather than 4 days.

A specific issue with the fidelity matrix approach is that it does not in itself distinguish between program elements that are more or less important to the outcomes. For example, program incentive payments were made as expected, but neither teachers nor students found them as important as other supports. If fidelity information were collected and reported in more detail (either by school or tabulated across schools) rather than what is used to create summary measures of fidelity under the matrix approach, it would be possible to have a better idea of which elements of programs were implemented with high fidelity at how many schools. This would provide a better understanding about how well the program was implemented and could

also provide school-level implementation measures that could be examined as a potential factor affecting outcomes. Data reduction techniques could be used to create summary scales that could be developed to identify how implementation of individual elements were correlated with one another.

Although the program may not have implemented all elements with fidelity, the impact findings from this evaluation—covering schools in Colorado and Indiana—are similar to those of previous evaluations of CRP as implemented in different states and at different time periods. Subject to the caveat that schools enter the program on a nonrandom basis, the findings from this and other evaluations provide evidence that the adoption of CRP is associated with increases in key student outcomes in the first year that can be sustained through the full 3 years of the program.

References

ACT. (2016). *The condition of college & career readiness 2016*. Retrieved from http://www.act.org/content/dam/act/unsecured/documents/CCCR_National_2016.pdf

Brown, R. S., & Choi, K. (2015). *Measuring the causal effect of the National Math + Science Initiative's College Readiness Program* (CRESST Report 847). Los Angeles: University of California, Los Angeles, National Center for Research on Evaluation, Standards, and Student Testing (CRESST).

College Board. (2014). *The 10th annual AP Report to the Nation.* Retrieved from http://media.collegeboard.com/digitalServices/pdf/ap/rtn/10th-annual/10th-annual-ap-report-to-the-nation-single-page.pdf

Holtzman, D. J. (2010). *The Advanced Placement Teacher Training Incentive Program (APTIP): Estimating the impact of an incentive and training program on students.* Unpublished manuscript. Washington, DC: American Institutes for Research.

Jackson, C. K. (2010). A little now for a lot later: A look at a Texas Advanced Placement incentive program. *Journal of Human Resources, 45*(3), 591–639.

Jackson, C. K. (2014). Do college-prep programs improve long-term outcomes? *Economic Inquiry, 52*(1), 72–99.

Morgan, R., & Klaric, J. (2007). *AP students in college: An analysis of five-year academic careers*. New York, NY: The College Board. Retrieved from http://research.collegeboard.org/sites/default/files/publications/2012/7/researchreport-2007-4-ap-students-college-analysis-five-year-academic-careers.pdf

National Math and Science Initiative (NMSI). (2013). *Increasing the achievement and presence of under-represented minorities in STEM fields* [white paper]. Retrieved from https://nms.org/Portals/0/Docs/whitePaper/NACME%20white%20paper.pdf

National Math and Science Initiative (NMSI). (2014). *College readiness program impact.* Retrieved from https://www.nms.org/Programs/ResearchResults.aspx

Somers, M., Zhu, P., Jacob, R., & Bloom, H. (2013). *The validity and precision of the comparative interrupted time series design and the difference-in-difference design in education evaluation* (MDRC working paper on research methodology). New York, NY: MDRC.

Stuart, E. A. (2010). Matching methods for causal inference: A review and a look forward. *Statistical Science: A Review Journal of the Institute of Mathematical Statistics, 25*(1), 1–21. http://doi.org/10.1214/09-STS313

Tai, R. H., Liu, C. Q., Almarode, J. T., & Fan, X. (2010). Advanced Placement course enrollment and long range educational outcomes. In P. M. Sadler, G. Sonnert, R. H. Tai, & K. Klopfenstein (Eds.), *AP: A critical examination of the Advanced Placement program* (pp. 109–119). Cambridge, MA: Harvard Education Press.

Vilorio, D. (2014, Spring). STEM 101: Intro to tomorrow's jobs. *Occupational Outlook Quarterly,* 1–11. Washington, DC: Bureau of Labor Statistics. Retrieved from http://www.bls.gov/careeroutlook/2014/spring/art01.pdf

Appendix A: Additional Impact Findings

In this appendix, we present the following impact findings for individual school cohorts: 1-year and 2-year impacts for Cohort 1 schools, 1-year and 2-year impacts for Cohort 2 schools, and 1-year impacts for Cohort 3 schools.

One-Year Impacts for Cohort 1 Schools

Table A-1 presents the findings about the 1-year impacts of the CRP program for Cohort 1 schools on the percentage of Grades 10–12 students taking an AP exam in math, science, and/or English, and the percentage of students passing an AP exam in these subjects. As the table shows, the percentage of students taking an AP exam and the percentage of students passing an AP exam increased for the treatment schools but decreased for the comparison schools from baseline to the first year of implementation across subject areas, with the exception only of the science AP exam passing rate, which increased for both the treatment and comparison schools.

The percentage of students in Grades 10–12 who took an AP exam in math, science, or English during the first year of CRP implementation, for example, increased by 5.69 percentage points from the average of the 3 baseline years for the treatment schools but decreased by almost a full (0.99) percentage point for the comparison schools over the same time period. The difference of 6.67 percentage points was statistically significant at the 0.001 level. The treatment schools also significantly outperformed the comparison schools in all the other outcomes examined after 1 year of implementation.

Table A-1. One-Year Impacts of CRP on Percentage of Students Taking AP Exam and Percentage of Students Passing AP Exam in Cohort 1 Schools in Colorado and Indiana, by Subject

Outcome	Average Deviation From Baseline Mean		Estimated Group Difference	Standard Error of Difference	P-Value
	Treatment Group	Comparison Group			
Percent Taking AP Exam					
Math/science/English	5.69	–0.99	6.67	1.29	0.000***
Math/science	3.31	–0.88	4.19	0.84	0.000***
Math	1.78	–0.51	2.30	0.50	0.000***
Science	3.31	–0.18	3.50	0.79	0.000***
English	3.00	–0.48	3.48	0.93	0.000***
Percent Passing AP Exam					
Math/science/English	2.85	–0.44	3.29	0.59	0.000***
Math/science	2.59	–0.16	2.75	0.53	0.000***
Math	1.15	–0.38	1.53	0.27	0.000***
Science	1.97	0.23	1.74	0.41	0.000***
English	1.31	–0.13	1.44	0.44	0.000***

Notes.

a. Number of schools = 36 (18 treatment, 18 comparison).

b. Average deviation from baseline mean for the treatment group is the unadjusted average deviation across treatment schools; average deviation for the comparison group was computed by subtracting the group difference estimated based on the impact model from the unadjusted average deviation for the treatment group.

c. P-values are based on two-tailed *t* tests: *p < .05; **p < .01; ***p < .001.

Two-Year Impacts for Cohort 1 Schools

Table A-2 presents the findings about the 2-year impacts of CRP for Cohort 1 schools in the two states on percentage of Grades 10–12 students taking an AP exam in math, science, and/or English, and the percentage of students passing an AP exam in these subjects. Overall, the findings show that the percentage of student taking an AP exam and the percentage of students passing an AP exam increased for the treatment schools across subject areas but decreased for the comparison schools from baseline to the second year of implementation in all subject areas except science. The percentage of students in Grades 10–12 who took an AP exam in math, science, or English during the second year of CRP implementation, for example, increased by 7.80 percentage points from the average of the 3 baseline years for the treatment schools but decreased by 2.29 percentage points for the comparison schools over the same time period. The difference of 10.09 percentage points was statistically significant at the 0.001 level. The treatment schools also significantly outperformed the comparison schools in all the other AP outcomes examined after 2 years of implementation.

Table A-2. Two-Year Impacts of CRP on Percentage of Students Taking AP Exam and Percentage of Students Passing AP Exam in Cohort 1 Schools in Colorado and Indiana, by Subject

Outcome	Average Deviation from Baseline Mean		Estimated Group Difference	Standard Error of Difference	P-Value
	Treatment Group	Comparison Group			
Percent Taking AP Exam					
Math/science/English	7.80	–2.29	10.09	1.44	0.000***
Math/science	5.23	–1.71	6.94	1.02	0.000***
Math	3.35	–0.82	4.17	0.80	0.000***
Science	3.81	–0.71	4.51	0.84	0.000***
English	4.47	–1.25	5.72	1.25	0.000***
Percent Passing AP Exam					
Math/science/English	3.28	–0.48	3.76	0.68	0.000***
Math/science	2.93	–0.26	3.19	0.50	0.000***
Math	1.84	–0.30	2.14	0.42	0.000***
Science	1.90	0.01	1.90	0.37	0.000***
English	1.58	–0.30	1.88	0.60	0.002**

Notes.

a. Number of schools = 36 (18 treatment, 18 comparison).

b. Average deviation from baseline mean for the treatment group is the unadjusted average deviation across treatment schools; average deviation for the comparison group was computed by subtracting the group difference estimated based on the impact model from the unadjusted average deviation for the treatment group.

c. P-values are based on two-tailed *t* tests: *p < .05; **p < .01; ***p < .001.

One-Year Impacts for Cohort 2 Schools

Table A-3 presents the findings about the 1-year impacts of CRP for Cohort 2 schools in both Colorado and Indiana on AP performance outcomes. These findings for Cohort 2 schools are

similar to the findings for Cohort 1 schools presented earlier in the appendix: CRP had significant positive impacts on all the AP outcomes examined, based on data across the two states. Overall, the findings show that the percentage of students taking an AP exam and the percentage of students passing an AP exam increased for both the Cohort 2 treatment and comparison schools across subject areas, but the differences in increase between CRP and comparison schools from baseline to the end of the first year of implementation were significant in all subject areas.

Table A-3. One-Year Impacts of CRP on Percentage of Students Taking AP Exam and Percentage of Students Passing AP Exam in Cohort 2 Schools in Colorado and Indiana, by Subject

Outcome	Average Deviation From Baseline Mean		Estimated Group Difference	Standard Error of Difference	P-Value
	Treatment Group	Comparison Group			
Percent Taking AP Exam					
Math/science/English	6.56	0.71	5.85	1.81	0.001**
Math/science	5.31	0.22	5.09	1.35	0.000***
Math	2.52	0.22	2.29	0.74	0.002**
Science	4.20	0.09	4.11	1.14	0.000***
English	4.14	1.11	3.02	1.53	0.048*
Percent Passing AP Exam					
Math/science/English	2.74	0.22	2.52	0.57	0.000***
Math/science	2.13	0.32	1.81	0.45	0.000***
Math	1.25	0.15	1.10	0.34	0.001**
Science	1.48	0.22	1.25	0.32	0.000***
English	1.32	0.09	1.23	0.39	0.002**

Notes.

a. Number of schools = 42 (21 treatment, 21 comparison).

b. Average deviation from baseline mean for the treatment group is the unadjusted average deviation across treatment schools; average deviation for the comparison group was computed by subtracting the group difference estimated based on the impact model from the unadjusted average deviation for the treatment group.

c. P-values are based on two-tailed *t* tests: *p < .05; **p < .01; ***p < .001.

Two-Year Impacts for Cohort 2 Schools

Table A-4 presents the findings about the 2-year impacts of CRP for Cohort 2 schools in the two states on AP performance outcomes. These findings suggest that CRP had significant positive impacts on all the AP outcomes examined after 2 years of implementation, based on data across the two states. Similar to the findings about the difference between the two study groups in the change in the AP exam passing rate from baseline years to the first follow-up year (2.52 percentages points), the group difference in the change in the AP exam passing rate from baseline to the second follow-up year (3.52 percentage points) was also statistically significant at the .001 level.

Table A-4. Two-Year Impacts of CRP on Percentage of Students Taking AP Exam and Percentage of Students Passing AP Exam in Cohort 2 Schools in Colorado and Indiana, by Subject

Outcome	Average Deviation From Baseline Mean		Estimated Group Difference	Standard Error of Difference	P-Value
	Treatment Group	Comparison Group			
Percent Taking AP Exam					
Math/science/English	8.84	–0.01	8.85	1.79	0.000***
Math/science	7.38	–0.53	7.91	1.66	0.000***
Math	3.73	–0.57	4.30	0.87	0.000***
Science	5.67	0.10	5.57	1.43	0.000***
English	5.47	0.54	4.93	1.31	0.000***
Percent Passing AP Exam					
Math/science/English	3.69	0.17	3.52	0.87	0.000***
Math/science	2.99	0.27	2.72	0.67	0.000***
Math	1.97	0.01	1.96	0.49	0.000***
Science	1.83	0.30	1.53	0.44	0.001**
English	1.89	–0.01	1.90	0.59	0.001**

Notes.

a. Number of schools = 42 (21 treatment, 21 comparison).

b. Average deviation from baseline mean for the treatment group is the unadjusted average deviation across treatment schools; average deviation for the comparison group was computed by subtracting the group difference estimated based on the impact model from the unadjusted average deviation for the treatment group.

c. P-values are based on two-tailed *t* tests: *p < .05; **p < .01; ***p < .001.

One-Year Impacts for Cohort 3 Schools

The results for the 1-year impacts of the CRP program for Cohort 3 schools are summarized in Table A-5. Overall, the findings are positive and largely consistent with findings about the 1-year impacts for the first two cohorts. As the table shows, the percentage of students taking and passing an AP exam increased for both the treatment and comparison schools from the baseline to the first year of implementation across subject areas. All of the increases were significantly larger in the treatment schools than in the comparison schools, except for the percentage passing an AP exam in math/science and the percentage passing an AP exam in math, where the differences were not significant. The percentage of Grades 10–12 students who took an AP exam in math, science, or English during the first year of CRP implementation for these schools, for example, increased by 10.03 percentage points from the average of the 3 baseline years for the treatment schools but increased only by 0.89 percentage points for the comparison schools over the same time period. The difference of 9.14 percentage points was statistically significant at the .001 level.

Table A-5. First-Year Impacts of CRP on Percentage of Students Taking AP Exam and Percentage of Students Passing AP Exam in Cohort 3 Schools in Colorado and Indiana, by Subject

Outcome	Average Deviation From Baseline Mean		Estimated Group Difference	Standard Error of Difference	P-Value
	Treatment Group	Comparison Group			
Percent Taking AP Exam					
Math/science/English	10.03	0.89	9.14	2.14	0.000***
Math/science	7.29	0.55	6.74	1.54	0.000***
Math	3.09	0.10	2.99	1.23	0.015*
Science	5.61	0.74	4.87	1.40	0.001**
English	6.82	0.88	5.94	1.82	0.001**
Percent Passing AP Exam					
Math/science/English	3.38	0.77	2.61	1.03	0.012*
Math/science	2.06	0.80	1.26	0.79	0.111
Math	1.02	0.57	0.45	0.58	0.442
Science	1.64	0.41	1.23	0.58	0.033*
English	2.33	0.30	2.03	0.92	0.028*

Notes.

a. Number of schools = 38 (19 treatment, 19 comparison).

b. Average deviation from baseline mean for the treatment group is the unadjusted average deviation across treatment schools; average deviation for the comparison group was computed by subtracting the group difference estimated based on the impact model from the unadjusted average deviation for the treatment group.

c. P-values are based on two-tailed *t* tests: *p < .05; **p < .01; ***p < .001.

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